Santa Clara Valley Water District

TECHNICAL MEMORANDUM

LAGUNA SECA WETLAND GROUNDWATER ANALYSIS

Prepared for
00044030 SMP Mit Laguna Seca Freshwater

Groundwater Monitoring and Analysis Unit

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LAGUNA SECA WETLAND GROUNDWATER ANALYSIS

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EXECUTIVE SUMMARY

The Laguna Seca freshwater wetland habitat project is being considered in the northern part of Coyote Valley to help meet regulatory mitigation measures associated with necessary stream maintenance activities elsewhere in the county. Understanding groundwater conditions is critical to assessing the feasibility of this project. A numeric groundwater flow model is used to assess groundwater conditions in the vicinity the project area resulting from two different operational scenarios. The model shows two significantly different responses in the aquifer system as affected by groundwater extraction, stream flow in Coyote and Fisher creeks, and the possible re-operation of Coyote Canal diversion.

The model covers an area of about 15 square miles, and is bounded to the southeast by a groundwater divide, to the southwest by the Santa Cruz Mountains, to northwest by the convergence of Santa Teresa Hills, Tulare Hill, and the Diablo Range at Coyote Narrows; and to the northeast by the Diablo Range. The model area is underlain by poorly consolidated alluvium which provides for high quality groundwater for domestic, agricultural, and municipal supply.

Two model scenarios were formulated and simulated using the calibrated model. In the first scenario, Coyote Canal, designed to deliver releases from Anderson reservoir to Santa Clara Plain and the northern portions of Coyote Valley, is non-operational. The second model scenario uses all the same climatic and hydrologic conditions as the first scenario except Coyote Canal is returned to service during the dry season, thus limiting replenishment of the aquifer. The findings of the model scenarios are summarized below:

Scenario 1 - Coyote Canal non-operational

- Forecasted water table in Laguna Seca area fluctuates near land surface similar to the current conditions.
- Subbasin groundwater outflow is towards the northwest into the Santa Clara subbasin similar to the groundwater outflow under natural conditions.
- Seasonal return of groundwater derived baseflow into Fisher and Lower Coyote creeks is observed throughout the simulation period similar to the current groundwater conditions in the area.

II. Scenario 2 - Coyote Canal operational May – October of each year

- Forecasted groundwater level declines as the simulation proceeds, with a maximum head decline of 30 feet observed.

- Subbasin groundwater outflow towards Santa Clara area decreases as the simulation proceeds. Groundwater flow direction from Santa Clara to Coyote Valley is observed near the end of the simulation period.
- Seasonal return of groundwater derived baseflow into Fisher and Lower Coyote creeks is impacted. Seasonal return of groundwater derived baseflow into Fisher and Lower Coyote creeks is not observed starting 2012.

This modeling effort suggests the aquifer system responds markedly different to operation of Coyote Canal in the Laguna Seca area compared to when dry season flows are released into Coyote Creek. One limitation to this analysis is the application of one year of measured river stage data to all 21 years of the simulation period may not reflect the impacts of long term wet and dry hydrologic conditions in the valley very well. It is recommended that future modeling efforts attempt to refine hydrologic input data further.

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LAGUNA SECA WETLAND GROUNDWATER ANALYSIS

Introduction

The Laguna Seca Wetland area is located in the north western portion of Coyote Valley, approximately half mile north of the intersection of Santa Teresa Boulevard and Bailey Ave (Figure 1). The wetland area is bounded on the south, west, and north by the Santa Teresa Hills; on the north east by Tulare Hill, and on the east by Fisher creek and Santa Teresa Blvd. The alluvial fill in the area is capped by clayey and silty materials that were formed as basin deposits or natural levees (Iwamura, 1995). Surface and groundwater flow in the area was blocked by the impervious bedrock of the Santa Teresa Hills, Tulare Hill, and by the low permeability natural levee of Fisher Creek. In the general vicinity of the Laguna Seca area, groundwater rises and discharges to the ground surface, and as baseflow in Fisher and Coyote creeks. These discharges are caused by the narrowing width and the rising of the basement rock in the vicinity of Coyote narrows and Laguna Seca area (Iwamura, 1995).

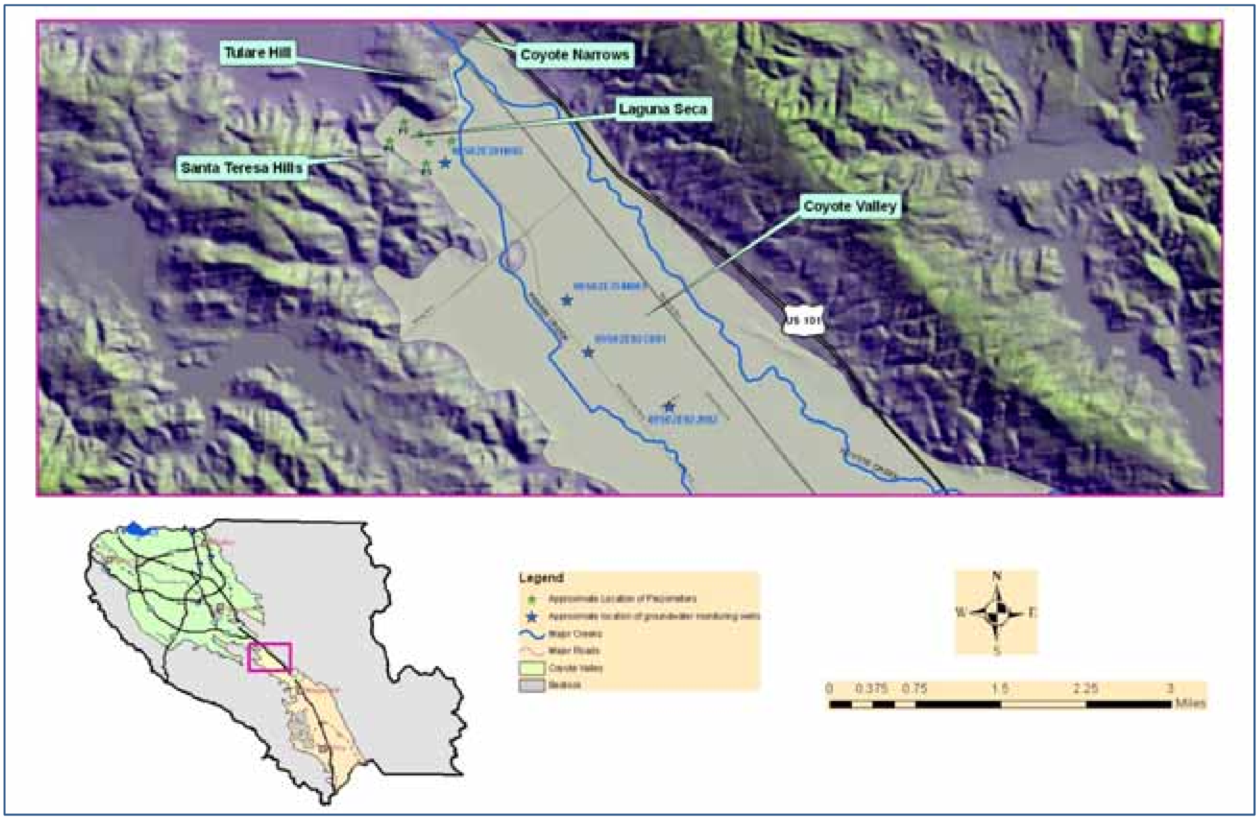

Figure 1. Location map of Laguna Seca in Coyote Valley

The Laguna Seca area is historically an area of shallow groundwater (Figure 2) and has been influenced by a variety of activities over the years, including the construction of drains and the conversion from marsh land to agricultural land in the 1920s, controlled dry season releases of water to Coyote Creek, construction and operation of the Coyote Canal diversion, and increased agricultural, domestic and municipal groundwater pumping. Deep percolation of stream flow along Coyote Creek represents the principal recharge to the aquifer system in Coyote Valley (Iwamura, 1995). Historically, surface water releases from Anderson reservoir were regulated based on the level of groundwater in Laguna Seca area such that those lands would not become inundated as a result of District operations. More complete documentation of the history of Laguna Seca can be found in the SCVWD internal report by Joe Aguilera (Revised July 2007).

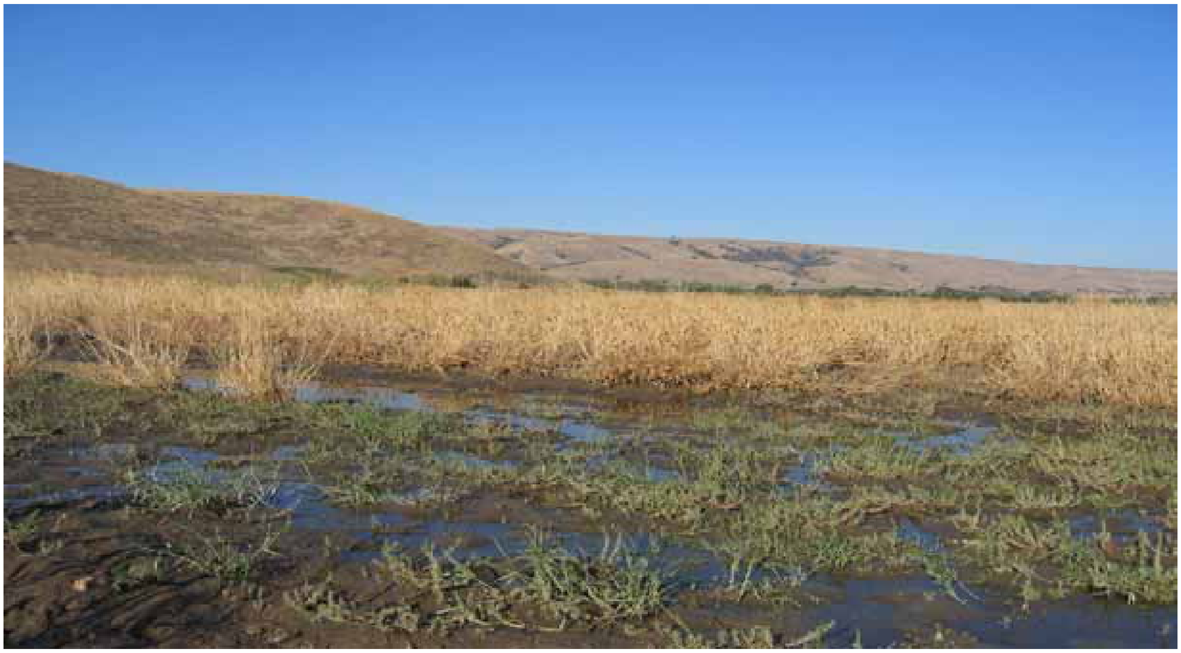

Figure 2. Shallow groundwater seepage in Laguna Seca area (from Coyote Creek Watershed Historical Ecology Study by San Francisco Estuary Institute, 2006)

Recently, the Laguna Seca area has been selected as a mitigation site to help the District meet regulatory requirements for environmental impacts resulting from needed stream maintenance activities. Stream maintenance activities, such as vegetation management and sediment removal, are important in providing flood protection for Santa Clara Valley residents and property. This mitigation project site will create and restore wetland habitat within approximately 74 acres of the 165 acre flood water detention basin currently planned for the Coyote Valley Research Park.

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Coyote Valley Groundwater Model Background

In 1999, Calpine/Bechtel hired CH2M Hill to conduct an evaluation of groundwater resources in the Coyote Valley related to the development of a power generation facility near Coyote Narrows (CH2M Hill, 2000) for the Public Utility Commission as part of their permit process. This groundwater evaluation included an assessment of the groundwater budget and development of a numerical groundwater flow model to predict the groundwater level response to increased groundwater use by the proposed facility. In 2000, CH2M Hill developed the Coyote Valley groundwater model using Microfem finite element method for the Metcalf Energy Center. CH2M Hill transformed the Microfem numerical code to a USGS MODFLOW finite difference model.

The District evaluated the feasibility of using the CH2M Hill Coyote Valley groundwater model in 2003 (Review of Coyote Valley Groundwater Model, Vanessa Reymers). The review recommended that the CH2M Hill model developed for the Coyote Valley is a good starting point for District modeling efforts in Coyote. The District Groundwater Monitoring and Analysis Unit (GMAU) staff made significant modifications to the CH2M Hill model. These include modification of model boundaries, aquifer parameters, stress period lengths (monthly), model areal extent, model package settings. More complete documentation of the modifications of the CH2M Hill model can be found in the GMAU internal report (2005). Following these extensive changes, the model was recalibrated and the calibration was verified. The model serves as a regional groundwater flow model with adequate accuracy. More complete documentation of the Coyote Valley groundwater model can be found in the report by CH2M Hill (2000).

The District uses the USGS MODFLOW numerical code for the Coyote model. The model consists of four active layers with 140 rows and 150 columns. The elevation and thickness of the layers are based on borehole lithlogy and drillers logs. The major boundary conditions of the model are no-flow, time variant constant head, and specific flux. The no-flow boundaries are defined on the east, west and at Cochrane Road in the south. A no-flow boundary is also defined at the bottom of layer 4. A time-variant constant head boundary is applied at Coyote Narrows to simulate subsurface outflow towards Santa Clara subbasin. At the top surface of the model, a prescribed flux boundary with a specified recharge representing areal recharge from precipitation, irrigation, septic return, evaporation, river inflow and outflow is applied. The main component of groundwater discharge is by pumping assumed to occur from model layers 2 and 3. Groundwater discharge to Fisher and lower Coyote creeks are simulated by the River Package. The model is calibrated and verified with available measured water level data. The simulated versus measured hydrographs at selected locations show a good match. The overall calibration of the model is reasonably good for a regional groundwater flow model.

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LAGUNA SECA WETLAND GROUNDWATER ANALYSIS

Modeling Objective

The objective of this groundwater simulation is to forecast the groundwater conditions in Laguna Seca Wetland area based on the two sets of operational strategies for a given set of hydrologic conditions. The data supporting these two strategies was provided by the wetland project team (river stage data along Coyote and Fisher creeks with and without the operation of Coyote Canal). The Coyote Valley groundwater model is used to simulate the Laguna Seca groundwater conditions. In 2009 the Groundwater Monitoring and Analysis Unit performed a groundwater simulation based on the modeling assumptions provided by the wetland project team and presented the simulation results to the wetland project. The findings of this simulation indicated that the forecasted groundwater level in Laguna Seca declines about 20 feet for the period of 1988 through 1992 and the groundwater level recovers to the current conditions after the long drought period.

This analysis and groundwater simulation is for July 1, 1987 through December 31, 2029. The first part of the simulation (July 1, 1987 to December 31, 2008) is performed based on actual historical data. The second part with additional 21 years of hydrology (1988 - 2008) is added at the end of 2008 to forecast the groundwater conditions with and without the operation of Coyote canal. Scenario 1 assumes surface water flow along Coyote and Fisher creeks without operation of Coyote Canal. Scenario 2 assumes Coyote Canal is operational during the summer months (May-October). Scenario 1 and 2 used similar surface water flow (river stage) data during the winter months (November – April). More detail information about the modeling assumptions are provided in Appendix A.

4 Modeling Output/Results

The groundwater simulation results such as water budgets and hydrographs under Scenario 1 and 2 are presented below.

I. Water Budget

The groundwater budget components (the annual inflow and outflow summary in acre-feet) in table 1 and 2 present the general and regional groundwater flow pattern, rate of groundwater condition, and subbasin exchange in the valley including the Laguna Seca wetland area.

In Scenario 1, the net annual average subbasin exchange between Coyote Valley and Santa Clara Plain is about 4,680 acre-feet per annum. Under natural conditions, groundwater flows from Coyote valley towards Santa Clara Subbasin. Scenario 1 simulation mimics the natural groundwater flow condition in the area, i.e. there is no groundwater flow from Santa Clara towards Coyote valley. Return of high groundwater as baseflow in Fisher and Lower Coyote creeks is observed throughout the simulation period.

In Scenario 2, groundwater flow from the Santa Clara Plain to Coyote Valley is observed which is opposite to current conditions. This occurs at the simulation period of 2026 (equivalent to 2005 hydrology). The net annual average subbasin exchange between Coyote Valley and Santa Clara Plain is about 2,260 af. Return of high groundwater as baseflow in Fisher and Lower Coyote creeks is diminished and is not observed starting in 2012 (equivalent to 1991 hydrology).

		INFLOW, AF				OUTFLOW, AF			
YEAR	Hydrology	SUBSURFACE INFLOW	AREAL RECHARGE	RIVER RECHARGE (Losing River)		RIVER RETURN FLOW(Gaining River)	GW PUMPING	SUBSURFACE OUTFLOW	EVAPOTRANSPIRATION
2009	1988	0	1,933	16,070		852	13,264	4,697	12
2010	1989	0	1,605	16,116		657	13,264	4,642	11
2011	1990	0	2,043	16,139		640	13,264	4,633	11
2012	1991	0	2,941	16,139		624	13,262	4,642	11
2013	1992	0	3,625	16,047		964	13,264	4,734	14
2014	1993	0	3,297	16,001		1,065	13,253	4,754	15
2015	1994	0	1,917	16,093		735	13,269	4,658	12
2016	1995	0	4,093	16,024		1,024	13,269	4,752	14
2017	1996	0	3,613	16,001		1,049	13,269	4,759	14
2018	1997	0	2,707	16,001		1,090	13,246	4,757	14
2019	1998	0	3,584	15,955		1,221	13,269	4,787	17
2020	1999	0	1,905	16,047		902	13,269	4,697	13
2021	2000	0	2,055	16,093		776	13,269	4,669	12
2022	2001	0	2,700	16,116		684	13,246	4,656	11
2023	2002	0	2,289	16,139		599	13,269	4,628	11
2024	2003	0	2,192	16,116		647	13,269	4,649	11
2025	2004	0	2,328	16,139		622	13,269	4,640	11
2026	2005	0	2,943	16,070		785	13,269	4,688	12
2027	2006	0	2,397	16,093		760	13,246	4,669	12
2028	2007	0	1,393	16,185		535	13,269	4,594	11
2029	2008	0	2,146	16,162		560	13,269	4,610	11
Min		**0**	**1,393**	**15,955**		**535**	**13,246**	**4,594**	**11**
Max		**0**	**4,093**	**16,185**		**1,221**	**13,269**	**4,787**	**17**
Avg		**0**	**2,557**	**16,083**		**800**	**13,264**	**4,682**	**12**

Table 1. Annual water budget summary for each water budget components under Scenario 1.

		INFLOW, AF				OUTFLOW, AF			
YEAR	Hydrology	SUBSURFACE INFLOW	AREAL RECHARGE	RIVER RECHARGE (Losing River)		RIVER RETURN FLOW(Gaining River)	GW PUMPING	SUBSURFACE OUTFLOW	EVAPOTRANSPIRATION
2009	1988	0	1,933	11,846		742	13,264	4,339	9
2010	1989	0	1,605	12,075		101	13,264	3,926	5
2011	1990	0	2,043	12,144		11	13,264	3,620	3
2012	1991	0	2,941	12,098		0	13,262	3,343	1
2013	1992	0	3,625	11,961		0	13,264	3,299	1
2014	1993	0	3,297	11,915		0	13,253	3,186	1
2015	1994	0	1,917	11,846		0	13,269	2,821	0
2016	1995	0	4,093	11,754		0	13,269	2,771	0
2017	1996	0	3,613	11,754		0	13,269	2,647	0
2018	1997	0	2,707	11,731		0	13,246	2,537	0
2019	1998	0	3,584	11,662		0	13,269	2,484	0
2020	1999	0	1,905	11,593		0	13,269	2,199	0
2021	2000	0	2,055	11,478		0	13,269	1,947	0
2022	2001	0	2,700	11,364		0	13,246	1,664	0
2023	2002	0	2,289	11,180		0	13,269	1,352	0
2024	2003	0	2,192	11,111		0	13,269	1,185	0
2025	2004	0	2,328	11,042		0	13,269	996	0
2026	2005	1	2,943	11,019		0	13,269	1,006	0
2027	2006	9	2,397	11,019		0	13,246	900	0
2028	2007	62	1,393	11,019		0	13,269	643	0
2029	2008	97	2,146	10,996		0	13,269	599	0
Min		**0**	**1,393**	**10,996**		**0**	**13,246**	**599**	**0**
Max		**97**	**4,093**	**12,144**		**742**	**13,269**	**4,339**	**9**
Avg		**8**	**2,557**	**11,553**		**41**	**13,264**	**2,260**	**0.9**

Table 2. Annual water budget summary for each water budget components under Scenario 2.

ii. Hydrograph:

The simulated and measured water level hydrograph for each modeled scenario in Laguna Seca wetland area and its vicinity are presented on Figures 4 through 13. The hydrographs under Scenario 1 (without the operation of Coyote Canal) on Figures 4 through 9 indicate that the forecasted groundwater level fluctuates near land surface whereas the forecasted groundwater level under scenario 2 declines as the simulation proceeds. Over time, a maximum water level decline of 30 feet is observed under scenario 2. As presented on Figures 4 through 10, the simulated water level hydrograph becomes flat when the forecasted water level drops below the bottom of the upper depth zone (model layer 1). The water level hydrograph from the lower depth zone (model layer 2) is used to estimate the maximum water level decline under scenario 2. The hydrographs on Figures 11 through 13 shows the groundwater levels south of Laguna Seca area under scenario 1 and 2. Figures 10 through 13 show a comparison of simulated groundwater levels under Scenario 1 and 2 with reference to the minimum (September 1991) measured water level at the selected groundwater monitoring wells. The September 1991 water level is the lowest water level reading in Coyote Valley since the beginning of the simulation period.

The Laguna Seca wetland simulation results are summarized below.

	(Scenario1)-Canal not Operating	**(Scenario2)-Canal Operating**
Water Level (see Figures of water level hydrograph of selected wells in Laguna Seca area). High and low groundwater levels	At Laguna Seca piezometer and groundwater monitoring wells - simulated water level fluctuates near ground surface elevation, i.e. similar to the current operation of Coyote Canal. Groundwater levels are high during wet months and low during dry months.	At Laguna Seca piezometer and groundwater monitoring wells - simulated water level falls more than 30 feet below ground surface. A maximum decline of 30 feet is observed towards the end of the simulation period. Groundwater levels are high during wet months and low during dry months.
Groundwater Gradient Change, Groundwater flow exchange between Coyote Valley and Santa Clara.	The natural and general groundwater flow direction is from Coyote to Santa Clara. Reversal of groundwater flow from Santa Clara to Coyote Valley is not observed.	At the beginning of the simulation, the natural and general groundwater flow direction is from Coyote to Santa Clara. Reversal of groundwater flow direction from Santa Clara to Coyote Valley is observed near the end of the simulation period
High groundwater flow along Fisher and Coyote Creeks	Groundwater derived baseflow is observed in the lower reaches of Coyote and Fisher creeks throughout the simulation period.	Groundwater derived baseflow is not observed in the lower reaches of Coyote and Fisher creeks starting 2012

Figure 3 – Location Map of Selected Piezometers and Groundwater Monitoring Wells in Laguna Seca and its vicinity

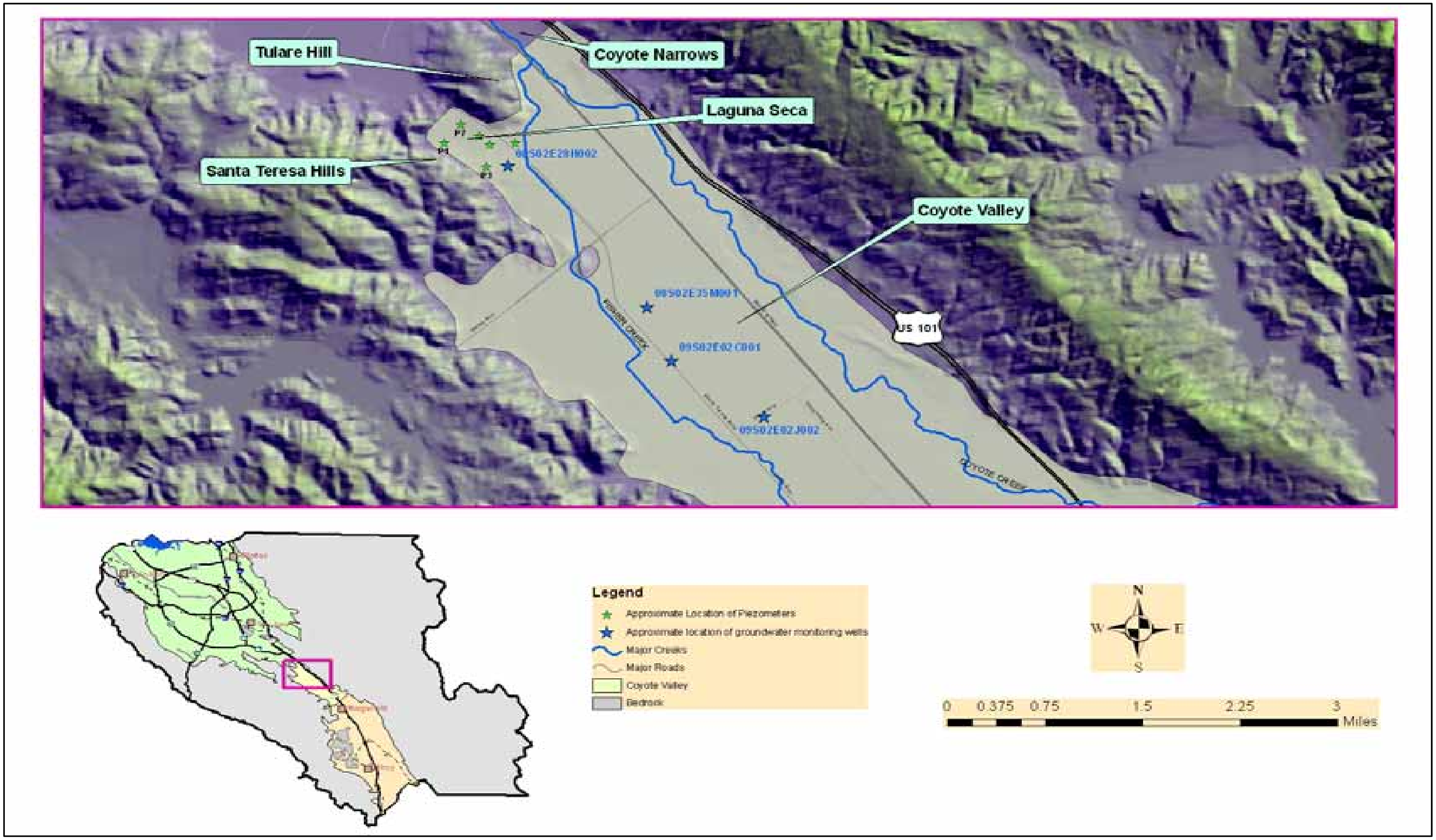


Figure 4. Measured and Simulated Groundwater level hydrographs at Piezometer - P1

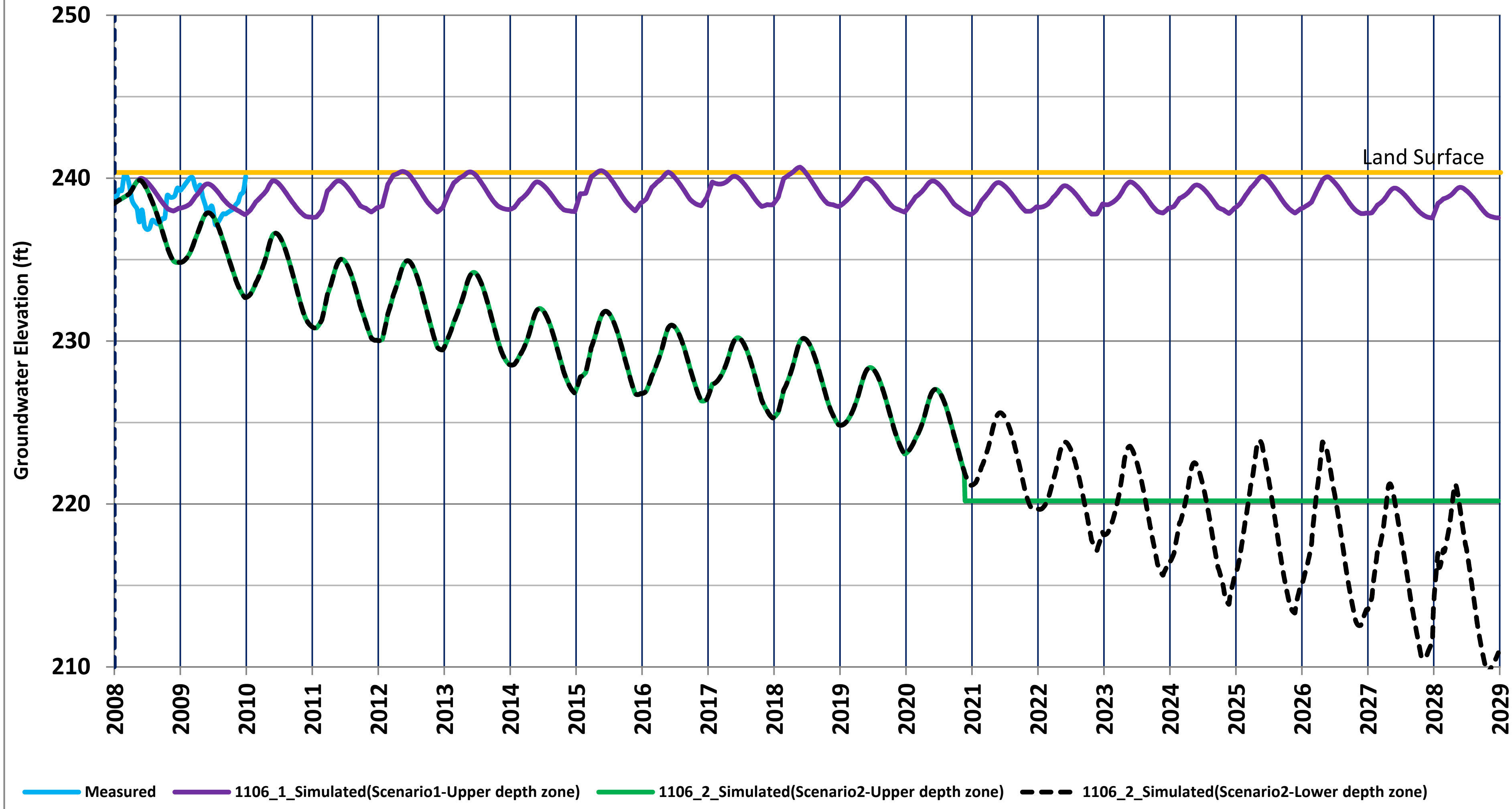


Figure 5. Measured and Simulated Groundwater level hydrographs at Piezometer - P3

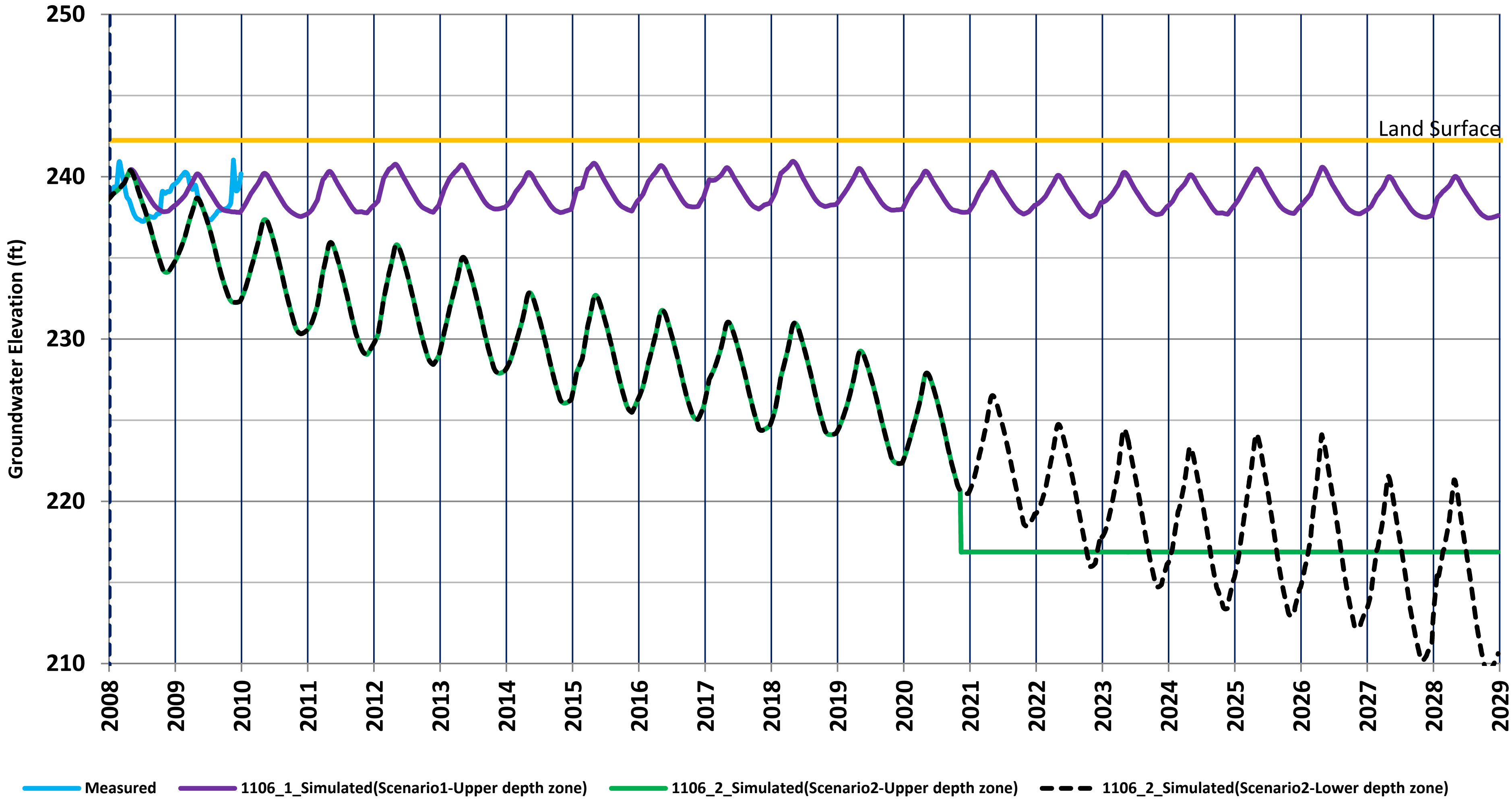


Figure 6. Measured and Simulated Groundwater level hydrographs at Piezometer - P7

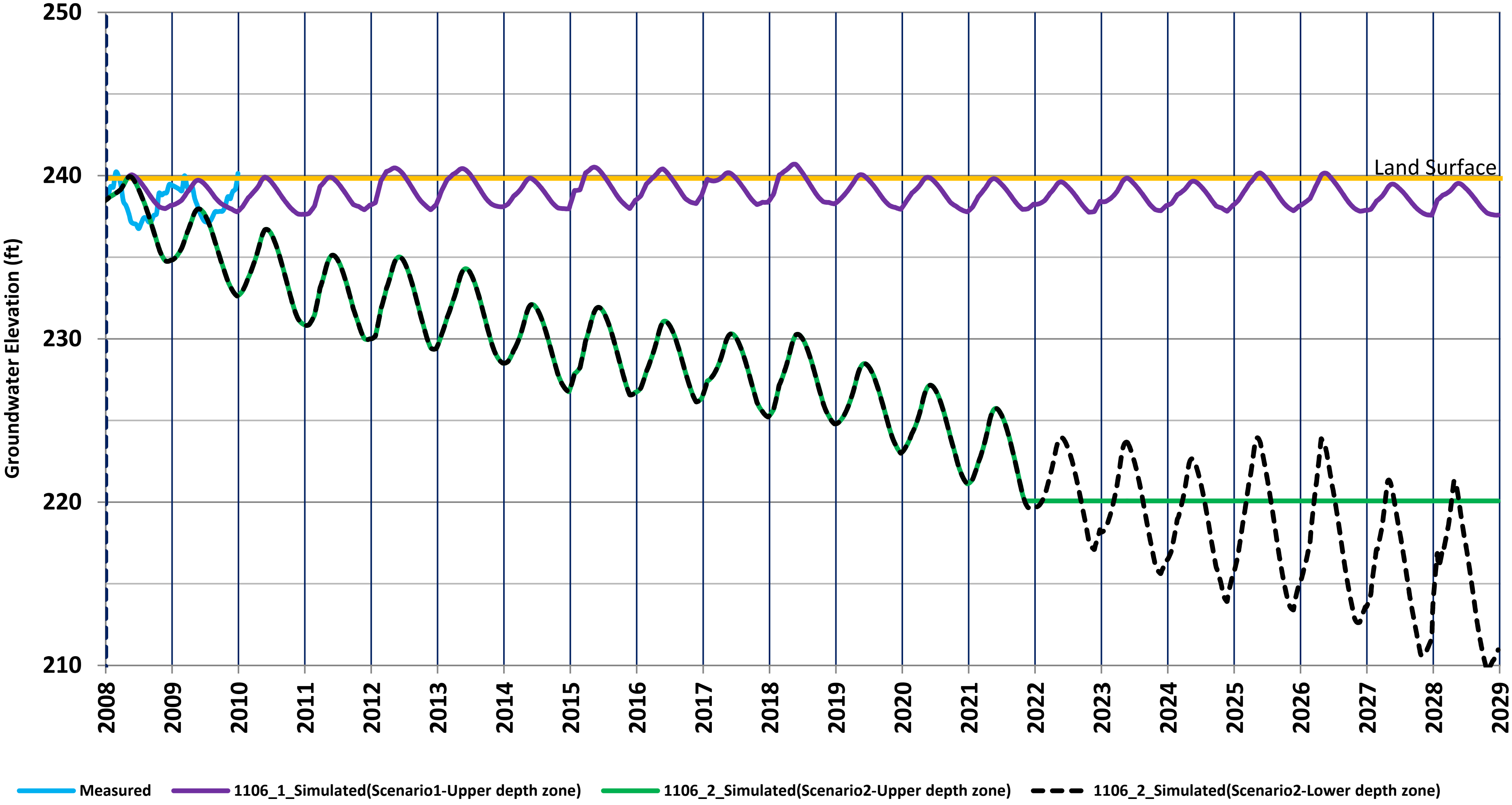


Figure 7. Measured and Simulated Groundwater level hydrographs at Piezometer - P8

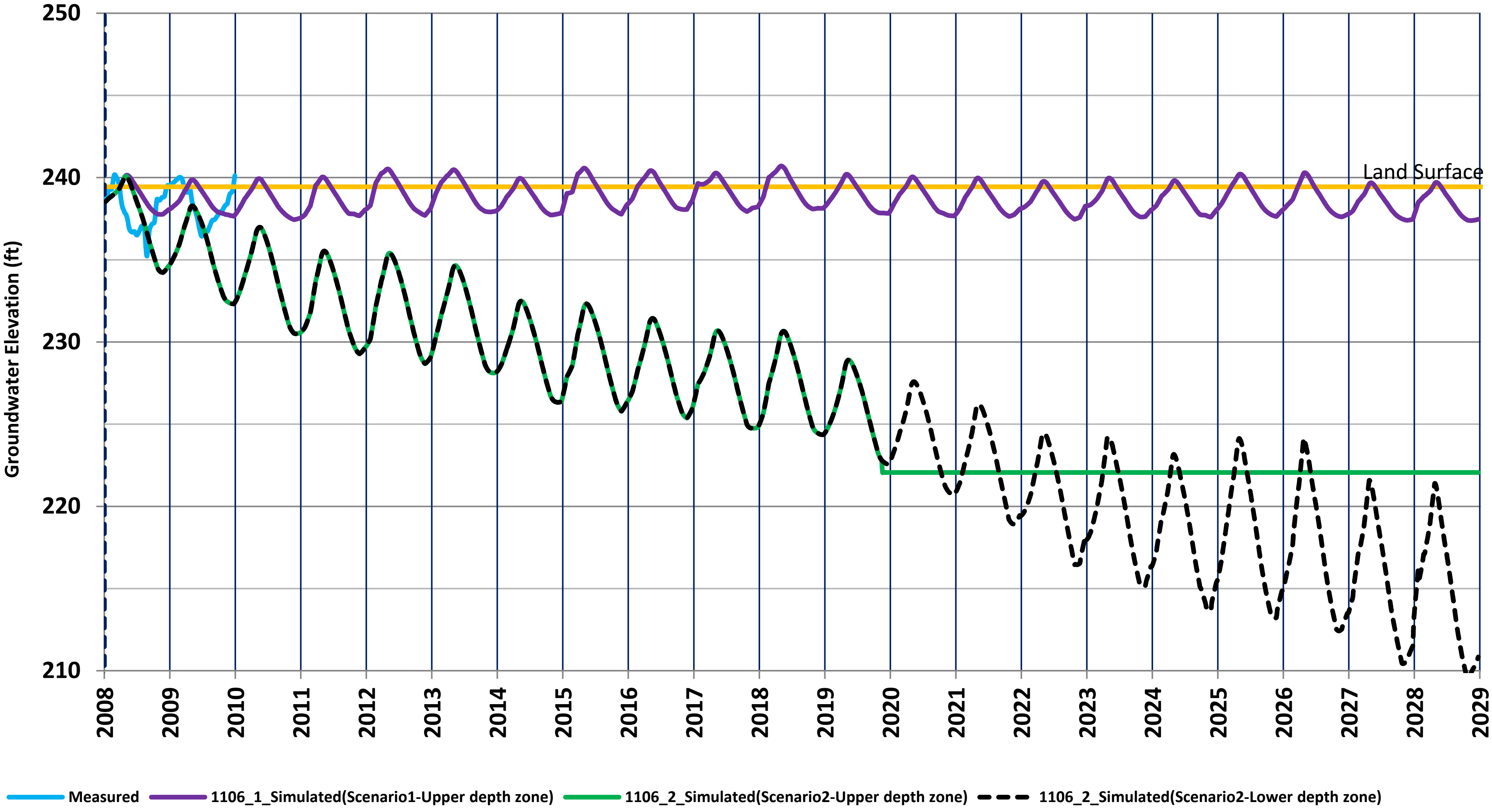


Figure 8. Measured and Simulated Groundwater level hydrographs at Piezometer - P9

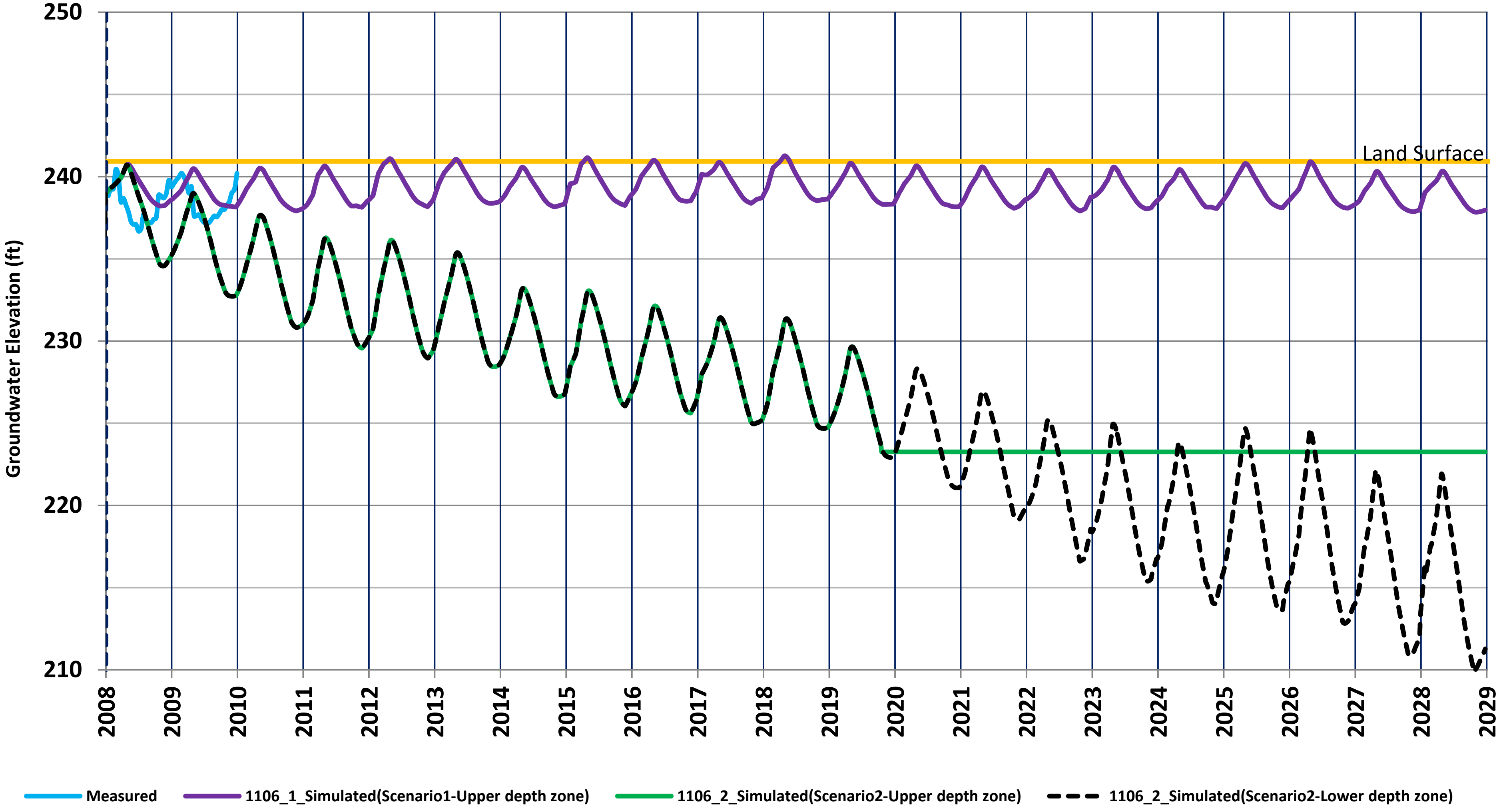


Figure 9. Measured and Simulated Groundwater level hydrographs at Piezometer - P11

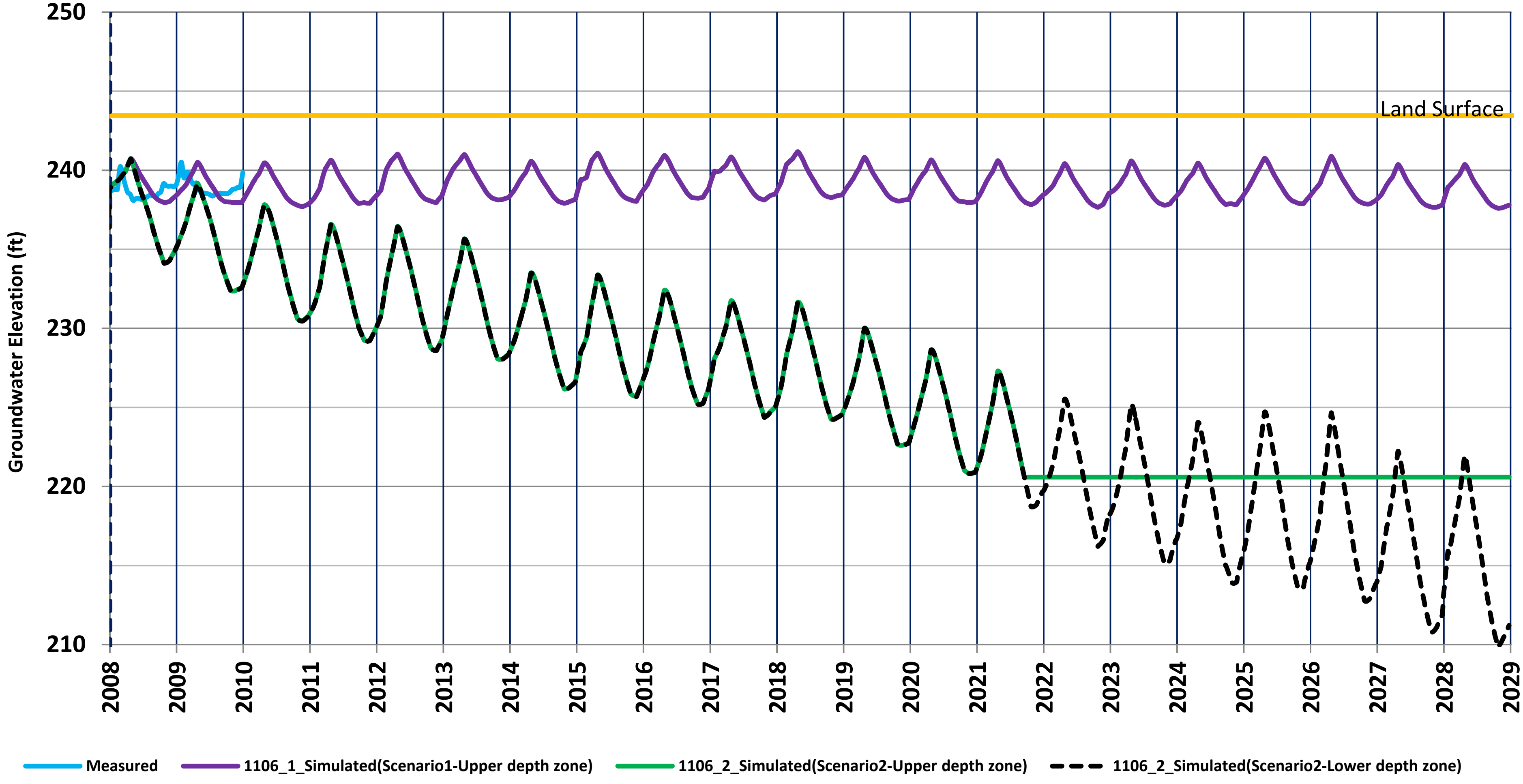


Figure 10. Measured and Simulated Groundwater level hydrographs at 08S02E28H002

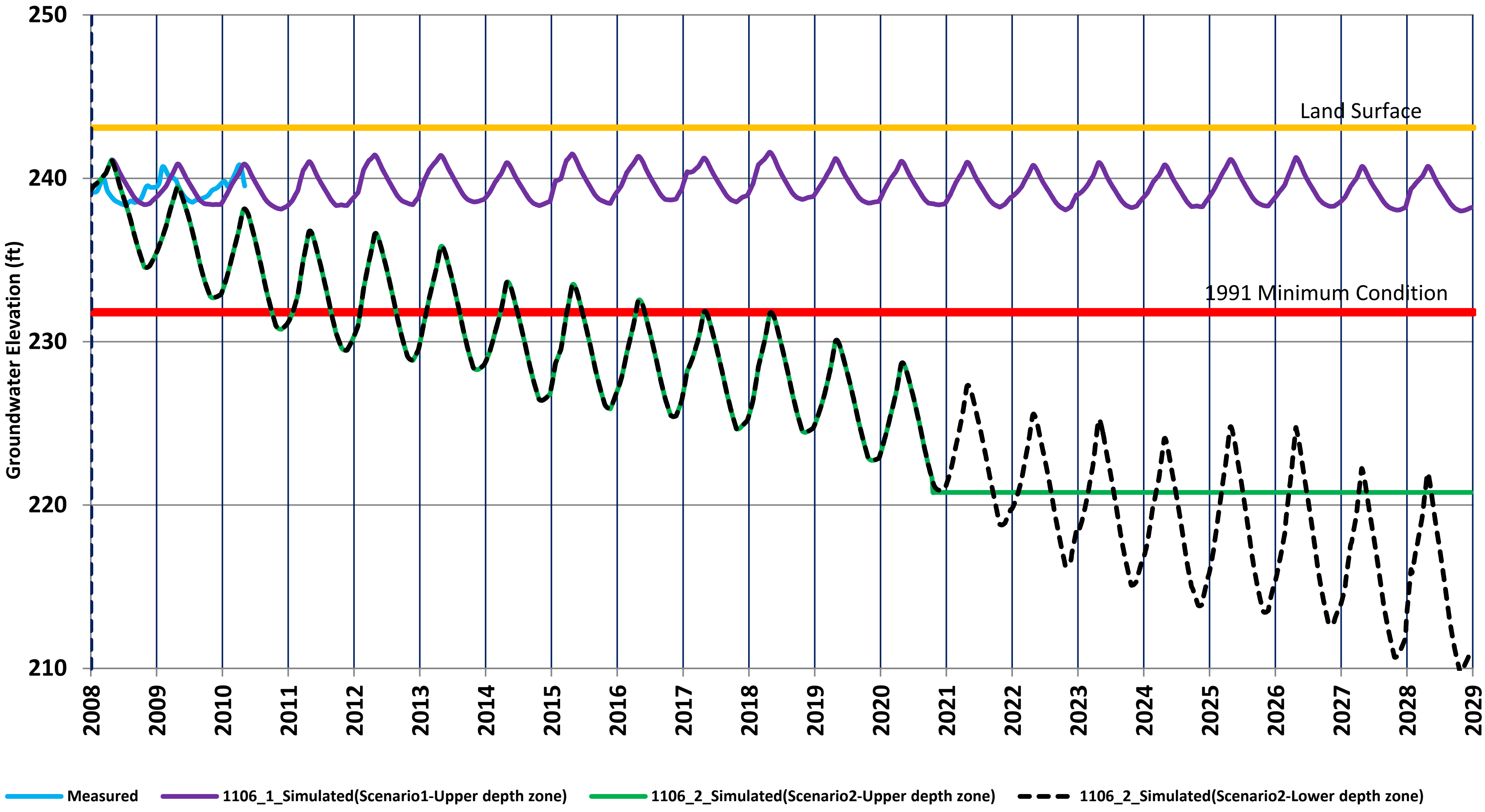
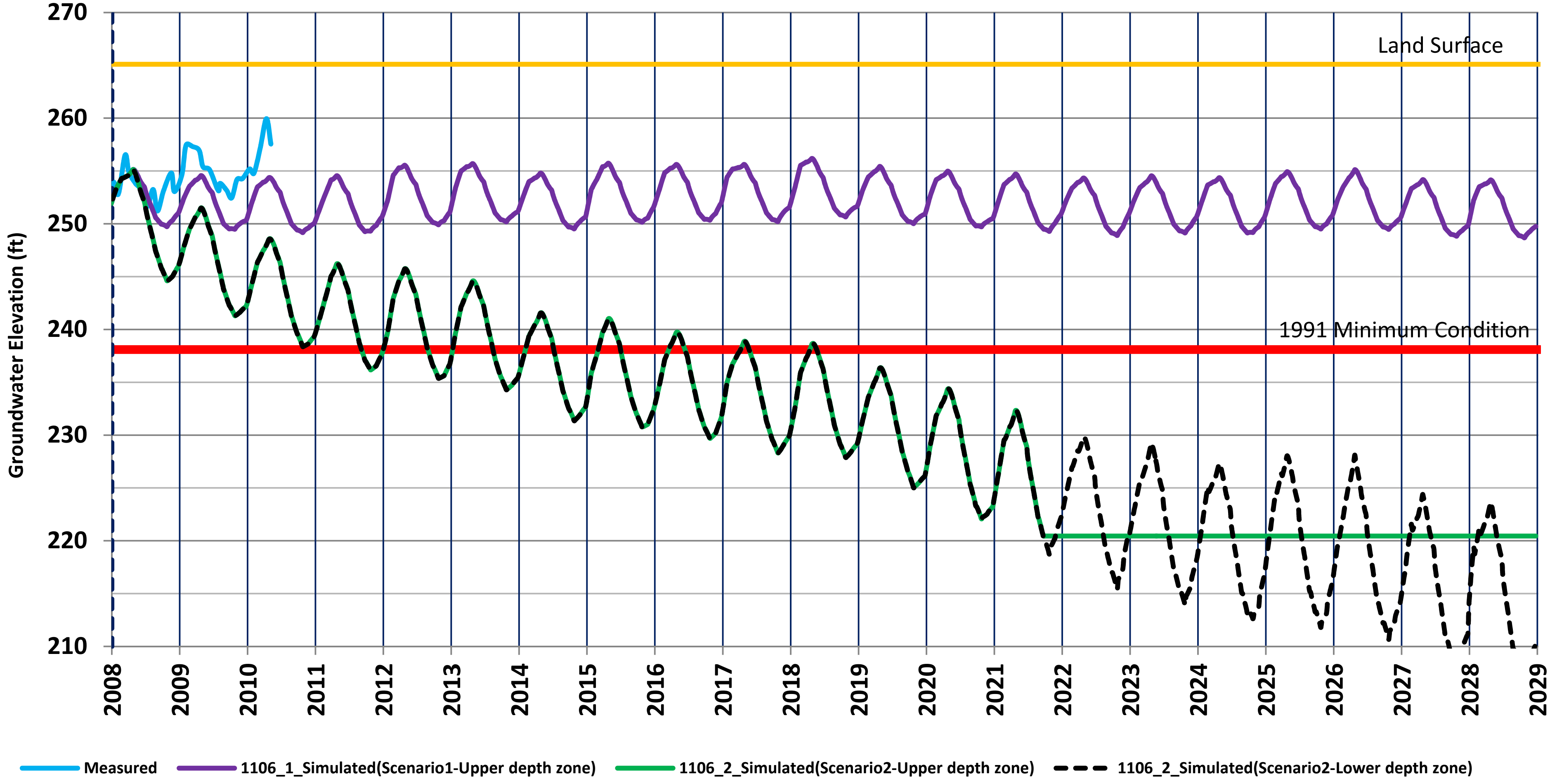


Figure 11. Measured and Simulated Groundwater level hydrographs at 08S02E35M001



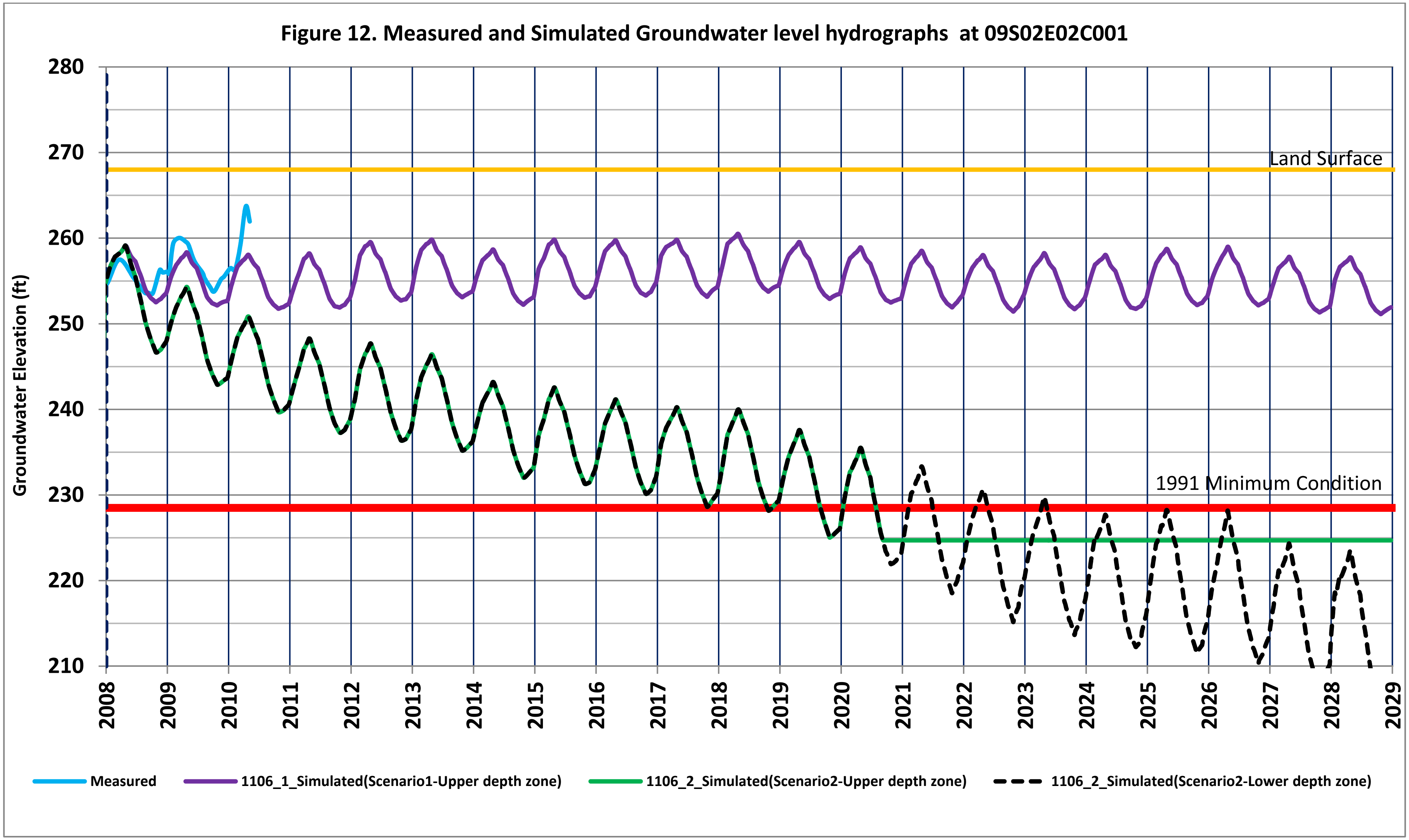


Figure 12. Measured and Simulated Groundwater level hydrographs at 09S02E02C001
Groundwater Elevation (ft)
280
270
260
250
240
230
220
210
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
Land Surface
1991 Minimum Condition
Measured
1106_1_Simulated(Scenario1-Upper depth zone)
1106_2_Simulated(Scenario2-Upper depth zone)
1106_2_Simulated(Scenario2-Lower depth zone)

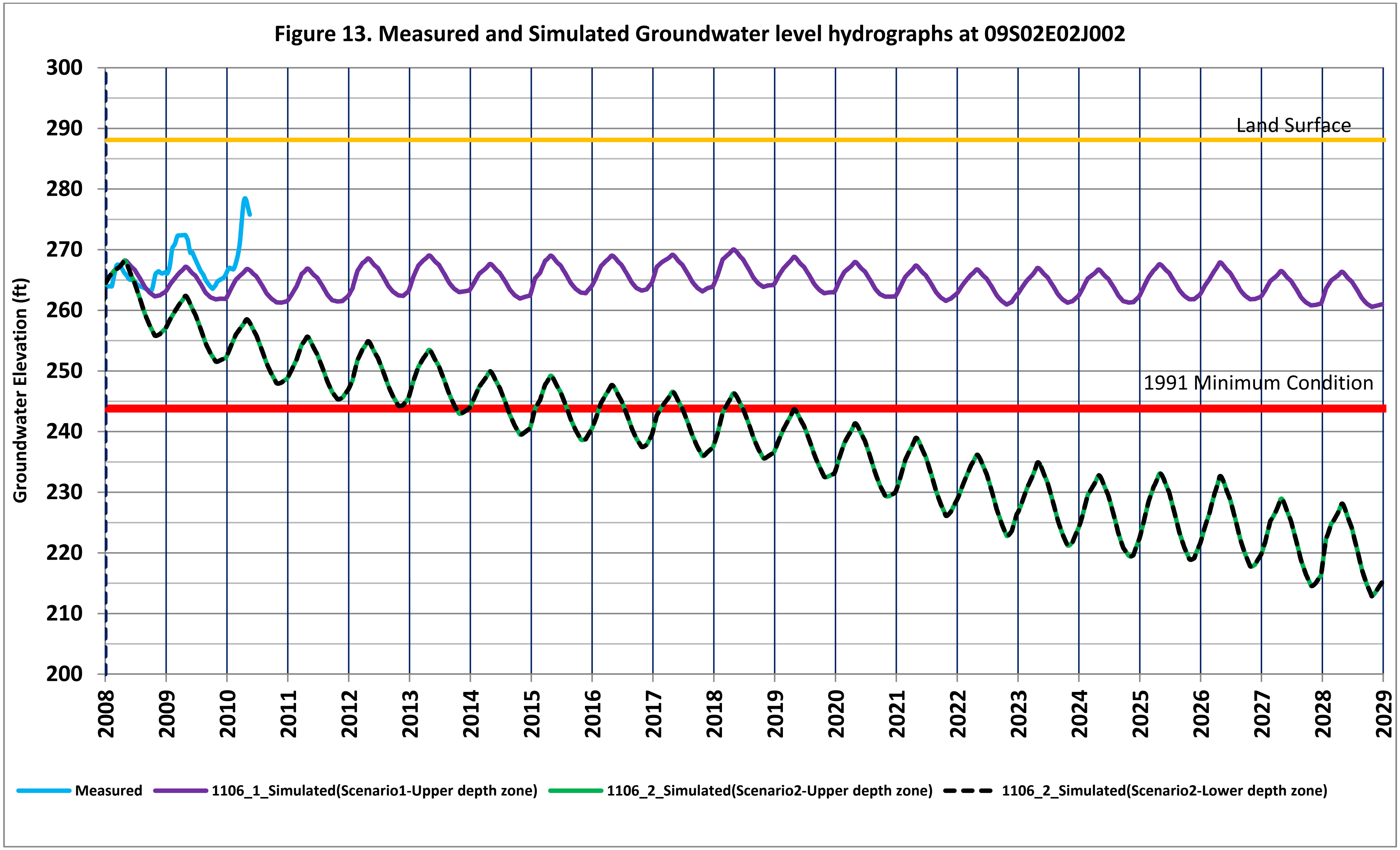


Figure 13. Measured and Simulated Groundwater level hydrographs at 09S02E02J002
Groundwater Elevation (ft)
300
290
280
270
260
250
240
230
220
210
200
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
Land Surface
1991 Minimum Condition
Measured
1106_1_Simulated(Scenario1-Upper depth zone)
1106_2_Simulated(Scenario2-Upper depth zone)
1106_2_Simulated(Scenario2-Lower depth zone)

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LAGUNA SECA WETLAND GROUNDWATER ANALYSIS

Conclusion/Recommendation

Aquifer behavior in Laguna Seca wetland area was modeled to predict the groundwater levels with and without the operation of Coyote Canal.

Based on the simulation results, the groundwater level under Scenario 1 (without the operation of Coyote Canal) fluctuates near ground surface elevation for the entire simulation period. Groundwater levels are high during wet months and low during dry months. The net annual average subbasin outflow from Coyote Valley towards Santa Clara is about 4,680 af/year. Seasonal return of groundwater derived baseflow into Fisher and Lower Coyote creeks is observed for the entire simulation period.

Under Scenario 2 (with the operation of Coyote Canal) condition, the groundwater level gradually declines as the simulation proceeds. Over time, a maximum of 30 feet of water level decline is observed in Laguna Seca wetland area. The maximum water level decline is observed especially during the summer months when the canal is in operation. A reversal of groundwater flow direction from Santa Clara to Coyote Valley is observed at the simulation period of 2026, near the end of the simulation period. Seasonal return of high groundwater as baseflow into Fisher and Lower Coyote creeks is not observed starting 2012.

The findings of the groundwater simulation results in the Laguna Seca wetland area indicated that the forecasted groundwater levels under model scenarios 1 and 2 have a different groundwater flow conditions and trend. A potential limitation to this study was the application of one year of Coyote river stage data to all 21 years of the simulation period which may not reflect the impacts of long term wet and dry hydrologic conditions in the valley very well. It is recommended that any future modeling efforts further refine model input data.

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Appendix A: Modeling Assumptions

Assumption

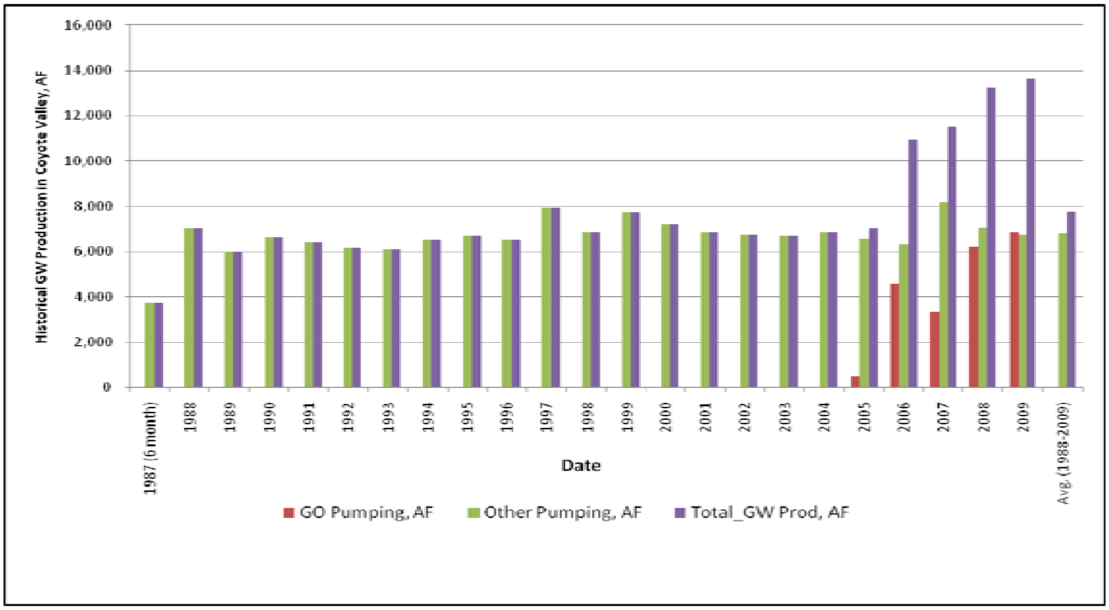
Below are modeling assumptions in running the Coyote groundwater model to assess groundwater condition in Laguna Seca wetland area with and without the operation of Coyote Canal. The assumption used in running the model include groundwater pumping, artificial recharge (using river stage), natural recharge, and model boundary conditions.

The overall simulation period is from July 1, 1987 through December 31, 2029. The first part (July 1, 1987 to December 31, 2008) is simulated based on actual historical data. Additional 21 years of hydrology is added at the end of 2008 to simulate the groundwater conditions under scenarios 1 and 2. Scenario 1 assumes surface water flow along Coyote and Fisher creeks without operation of Coyote Canal. Scenario 2 assumes Coyote Canal is operational during the summer months (May-October). Scenario 1 and 2 used similar surface water flow (river stage) data during the winter months (November – April).

	Historical	Scenario 1-No Flow in Coyote Canal (1104_1.LSW)	Scenario 2- Coyote Canal is Operational (1104_2.LSW)
Year	1987-2008	2009-2029	2009-2029
Groundwater Pumping	Actual	Constant pumping rate - Using actual 2008 pumping rate and distribution	Constant pumping rate - Using actual 2008 pumping rate and distribution
Artificial Recharge	Calculated using actual stage data	Calculated based on constant monthly river stage data provided by OPAU **(Scenario 1)**	Calculated based on constant monthly river stage data provided by OPAU **(Scenario 2)**
Hydrology	Actual	Using the historical hydrology - 1988 through 2008 (1988 = Hyd2009, 1989 = Hyd2010, etc)	Using the historical hydrology -1988 through 2008 (1988 = Hyd2009, 1989 = Hyd2010, etc)

Groundwater Pumping (13,260 AF)

The 2008 pumping rate and distribution is used in this (1104_1 & 1104_2) analysis for the period of 2009 through 2029. As presented in the graph below, 2009 groundwater pumping (13,600 AF) is the historical highest groundwater extraction in Coyote Valley since 1987. The difference between 2009 and 2008 groundwater pumping is only about 340 AF.



Artificial Recharge

The model river package calculates the groundwater recharge along Coyote and Fisher creeks based on the given river stage data under scenarios 1 and 2 below.

Scenario1 (No flow in Coyote Canal, current operation)

Month	# days	SF 7	Stage	SF 10	Stage	SF 82	Stage
		(cfs)	*(ft.)*	*(cfs)*	*(ft.)*	*(cfs)*	*(ft.)*
January	31	10.8	1.79	20.4	2.08	21.9	2.15
February	28	11.2	1.81	15.9	1.98	23.3	2.16
March	31	27	2.35	15.1	1.96	34.6	2.24
April	30	103.2	3.38	14.3	1.95	94.1	2.55
May	31	9.5	1.71	8.2	1.77	32.2	2.22
June	30	12.1	1.86	6.3	1.69	41.6	2.27
July	31	13.5	1.92	5.4	1.61	45.6	2.29
August	31	14.2	1.95	4.7	1.56	47.9	2.3
September	30	13.5	1.92	4.9	1.58	44.7	2.29
October	31	13.1	1.91	6.4	1.7	39.4	2.26
November	30	10.2	1.75	6.3	1.69	33.5	2.23
December	31	9	1.68	8.2	1.77	27.7	2.19

Scenario 2 (Canal in Operation, minimum summer flow in creek)

Month	# days	SF 7	Stage	SF 10	Stage	SF 82	Stage	Golf Course Rd.	Stage
		(cfs)		*(cfs)*		*(cfs)*		*(cfs)*	
January	31	10.8	1.79	20.4	2.08	21.9	2.15	-	-
February	28	11.2	1.81	15.9	1.98	23.3	2.16	-	-
March	31	27	2.35	15.1	1.96	34.6	2.24	-	-
April	30	103.2	3.38	14.3	1.95	94.1	2.55	-	-
May	31	0	0.44	0	1	16	2.1	1	0.06
June	30	0	0.44	0	1	16	2.1	1	0.06
July	31	0	0.44	0	1	16	2.1	1	0.06
August	31	0	0.44	0	1	16	2.1	1	0.06
September	30	0	0.44	0	1	16	2.1	1	0.06
October	31	0	0.44	0	1	16	2.1	1	0.06
November	30	10.2	1.75	6.3	1.69	33.5	2.23	-	-
December	31	9	1.68	8.2	1.77	27.7	2.19	-	-

Hydrology and Natural Recharge

The 21 year simulation period between 2008 and 2029 assumes the same climatic condition as measured during 1988 to 2008 period which includes one major drought period from 1988 to 1992. The natural recharge components are deep percolation from precipitation, irrigation return flow, and septic tank discharge. The historical rainfall data at Laguna Seca and Anderson Precipitation Gages for the period of 1988 to 2008 is used to estimate the deep percolation from rainfall.

Model boundary conditions (initial condition)

The simulation is starting in 1987 with initial head set at the end of June 1987. Additional 21 years of hydrology is added at the end of 2008 reflecting future condition.